Regional Projections of Net Greenhouse Gas Emissions and Reductions in Californian Agriculture

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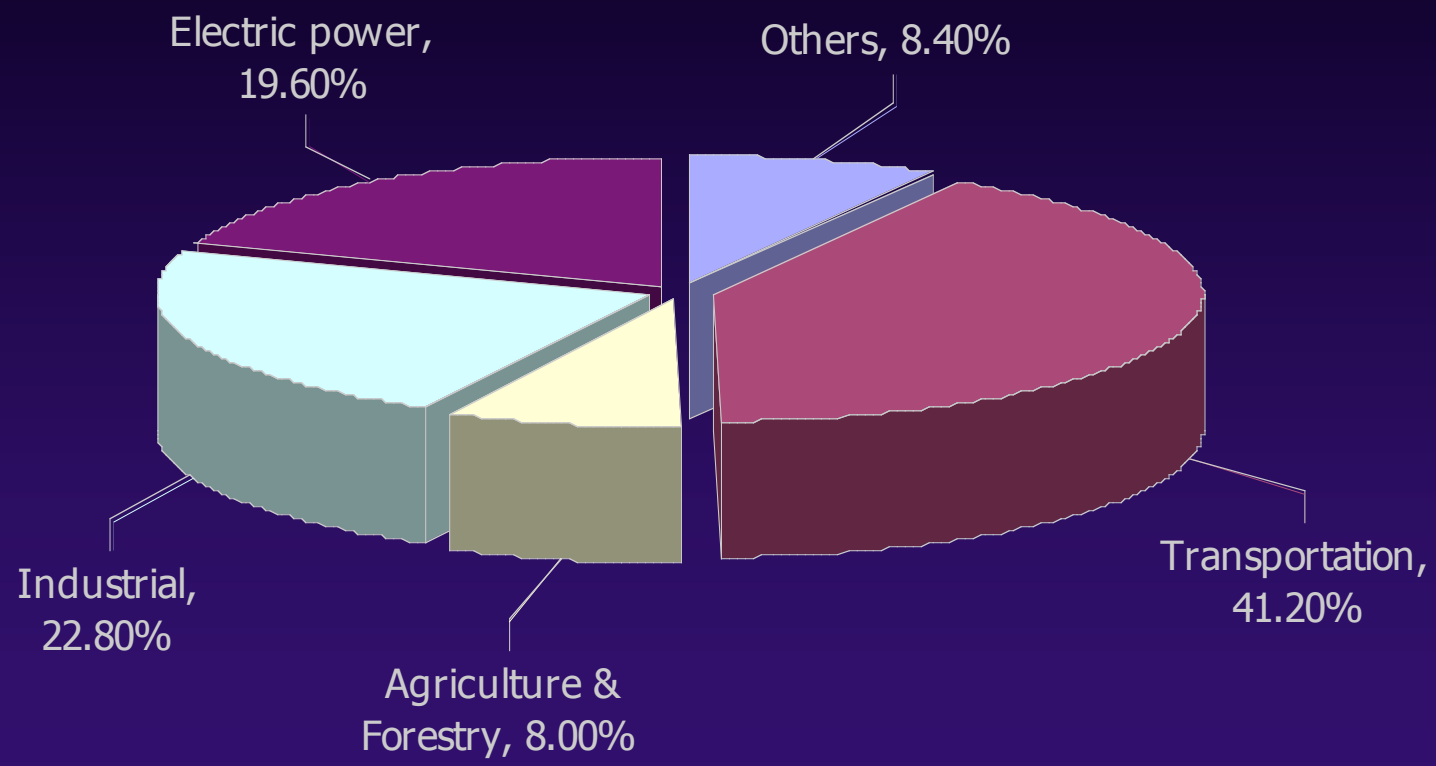
Source of greenhouse gases in CA

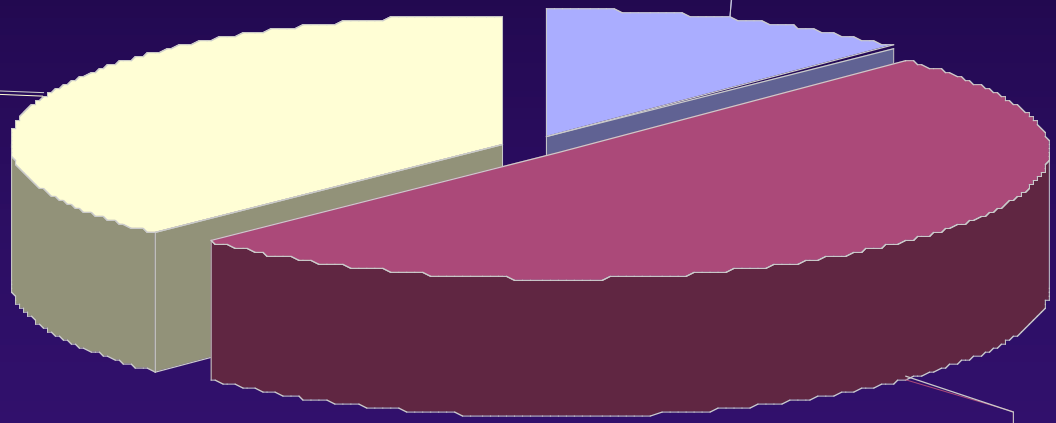


California Energy Commission, 2005

Composition and sources of greenhouse gases by agriculture

Sources: Fossil fuels, biomass burning, soil degradation

Sources: Livestock, manure, anaerobic soils (rice)



Sources: Fertilizer, crop residues, manure

California Energy Commission, 2005

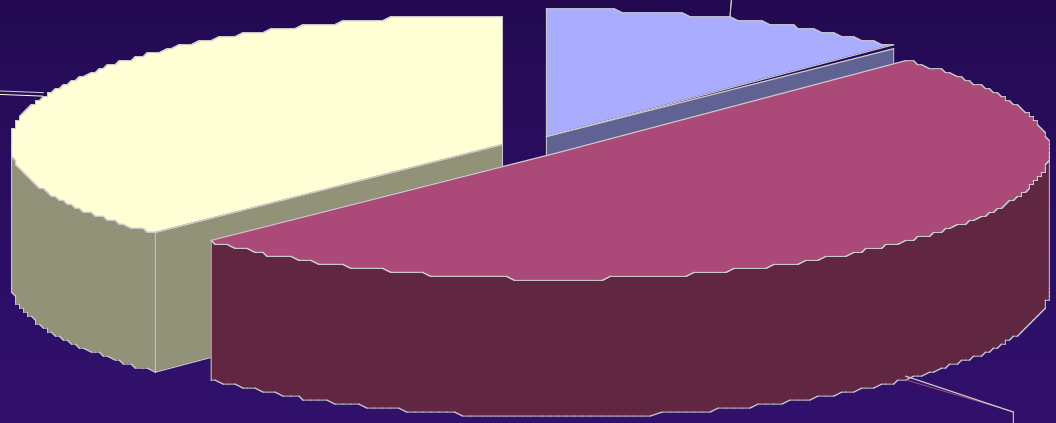
Composition and sinks of greenhouse gases by agriculture

Sources: Livestock, manure, anaerobic soils (rice)

Sinks: Aerobic soils, especially forests and grasslands

Sources: Fossil fuels, biomass burning, soil degradation

Sinks: Buildup soil organic matter and plant biomass



Sources: Fertilizer, crop residues, manure

Sinks: No sinks in soils

California Energy Commission, 2005

Practices for GHG mitigation

- Reduced or zero tillage
- Set-asides/conversions to perennial grass
- Winter cover crops
- More hay in crop rotations
- Higher residue (above- & below-ground) yielding crops
- Manure application and organic cropping
- Reducing fertilizer application rate

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Research question:

What is the potential for GHG mitigation by agriculture by changing practices for common crops and crop rotations in Yolo county, CA

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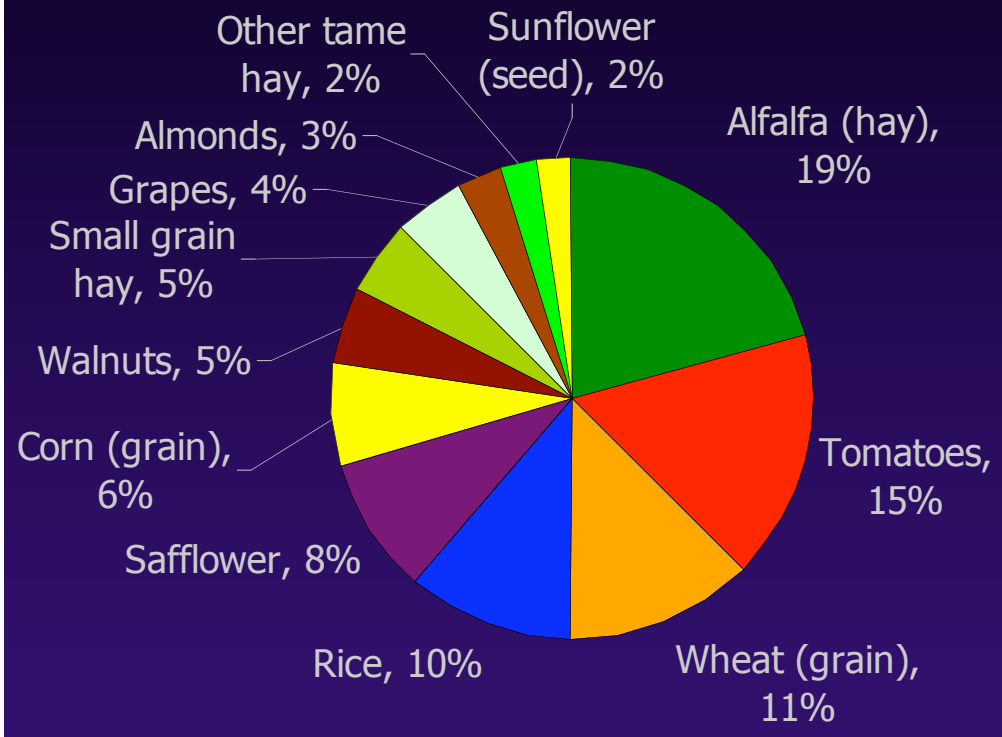
= emissions under alternative practices – emissions under conventional practices

Yolo county

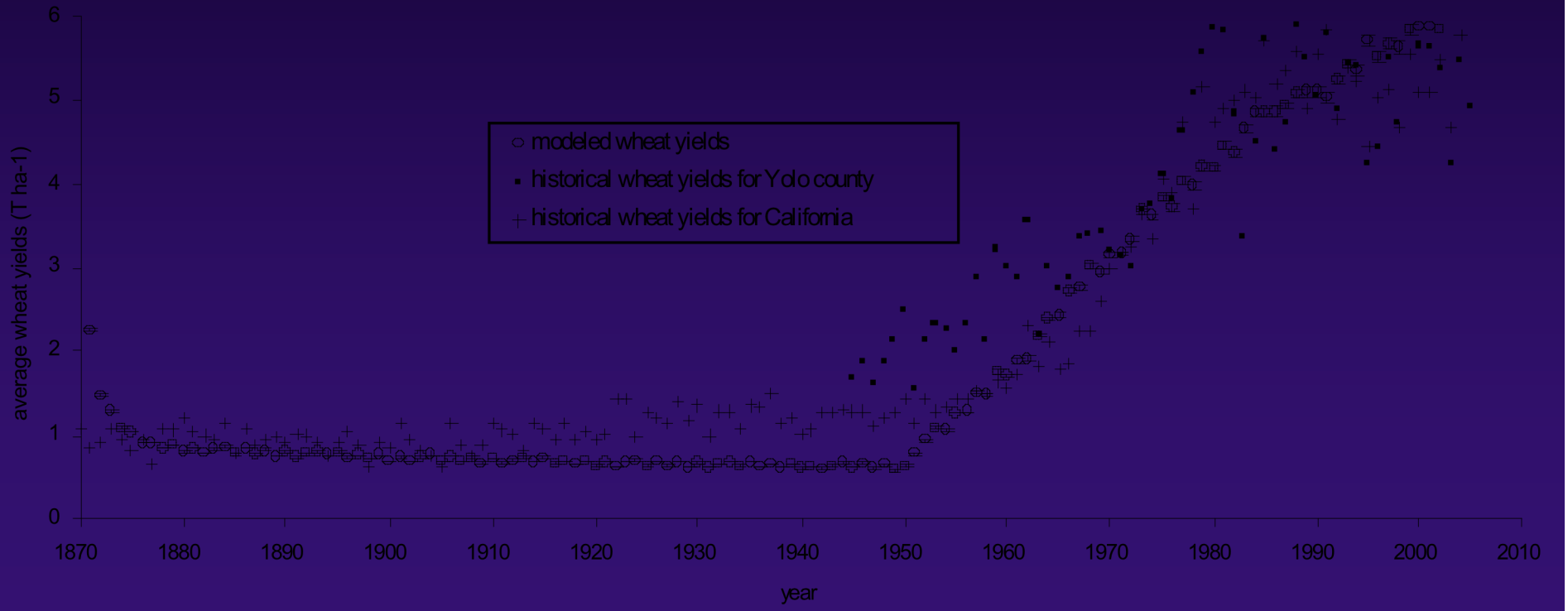


USDA 2002 Census

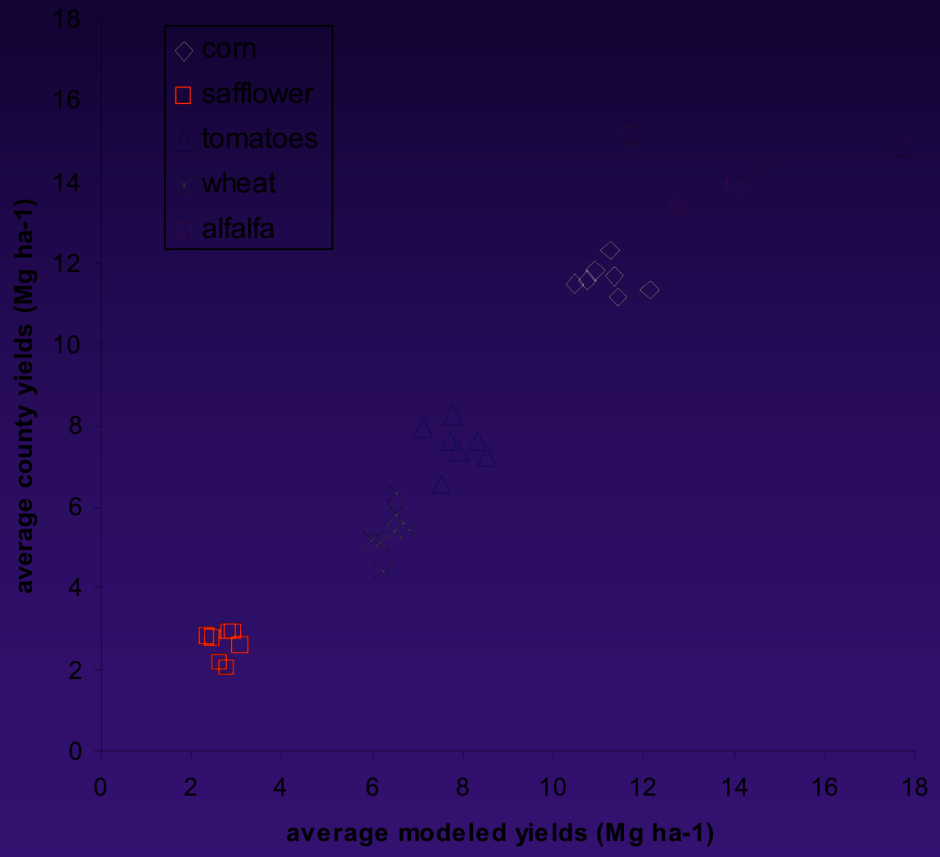
5 main crops (no rice) in typical rotations

DayCent model

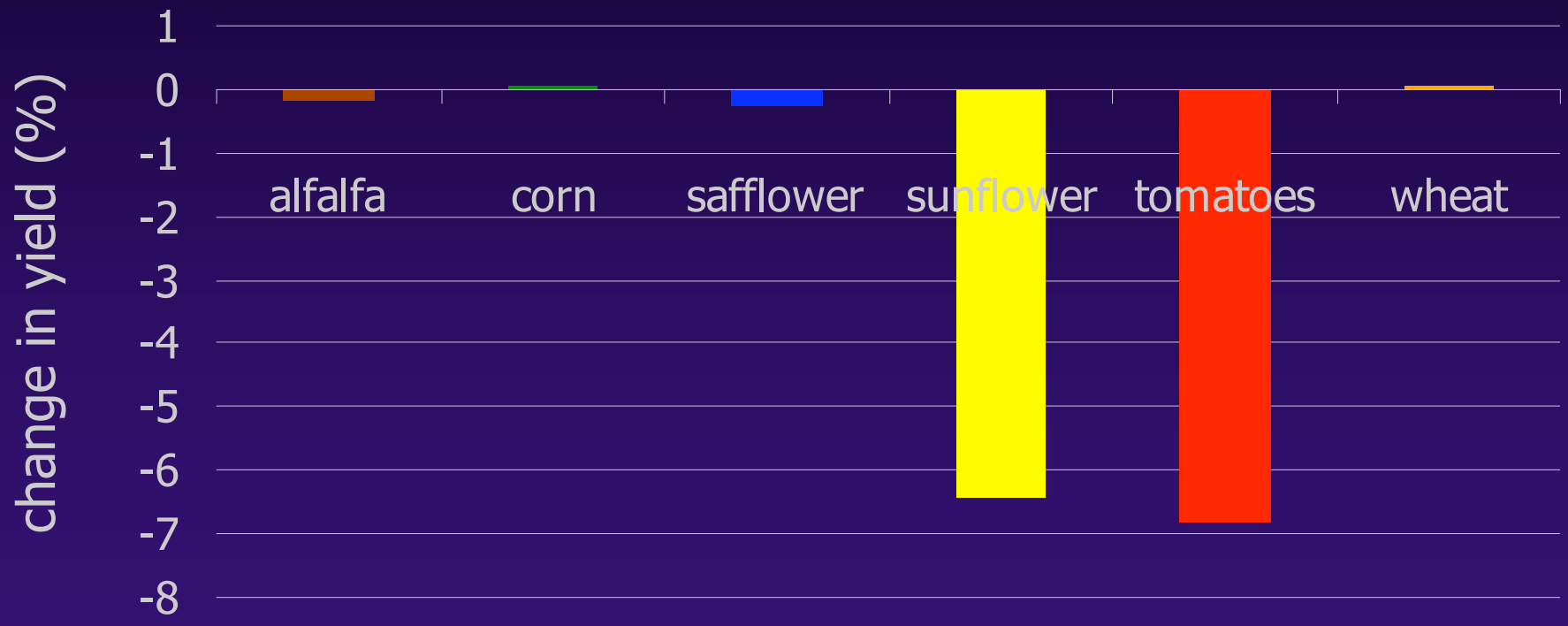
Validation (1): historical yields



Validation (2): current yields

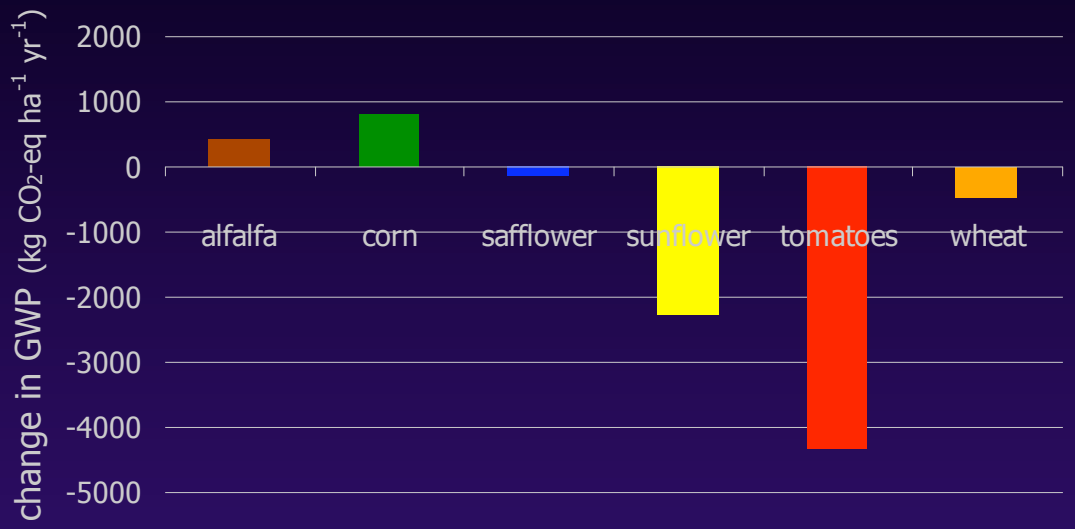


Results: conventional to reduced tillage – change in yield



Results: conventional to reduced tillage – GHG difference

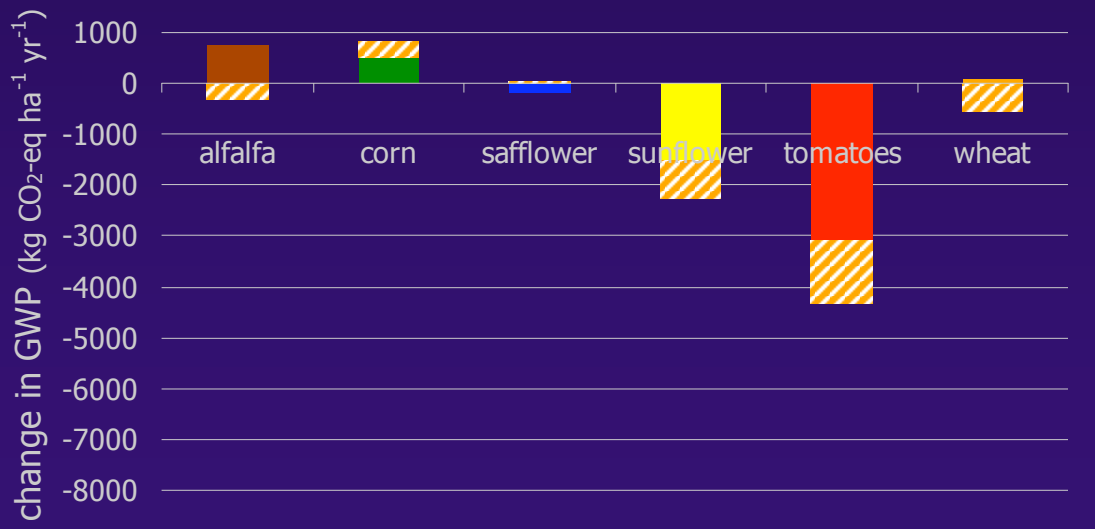
total change:



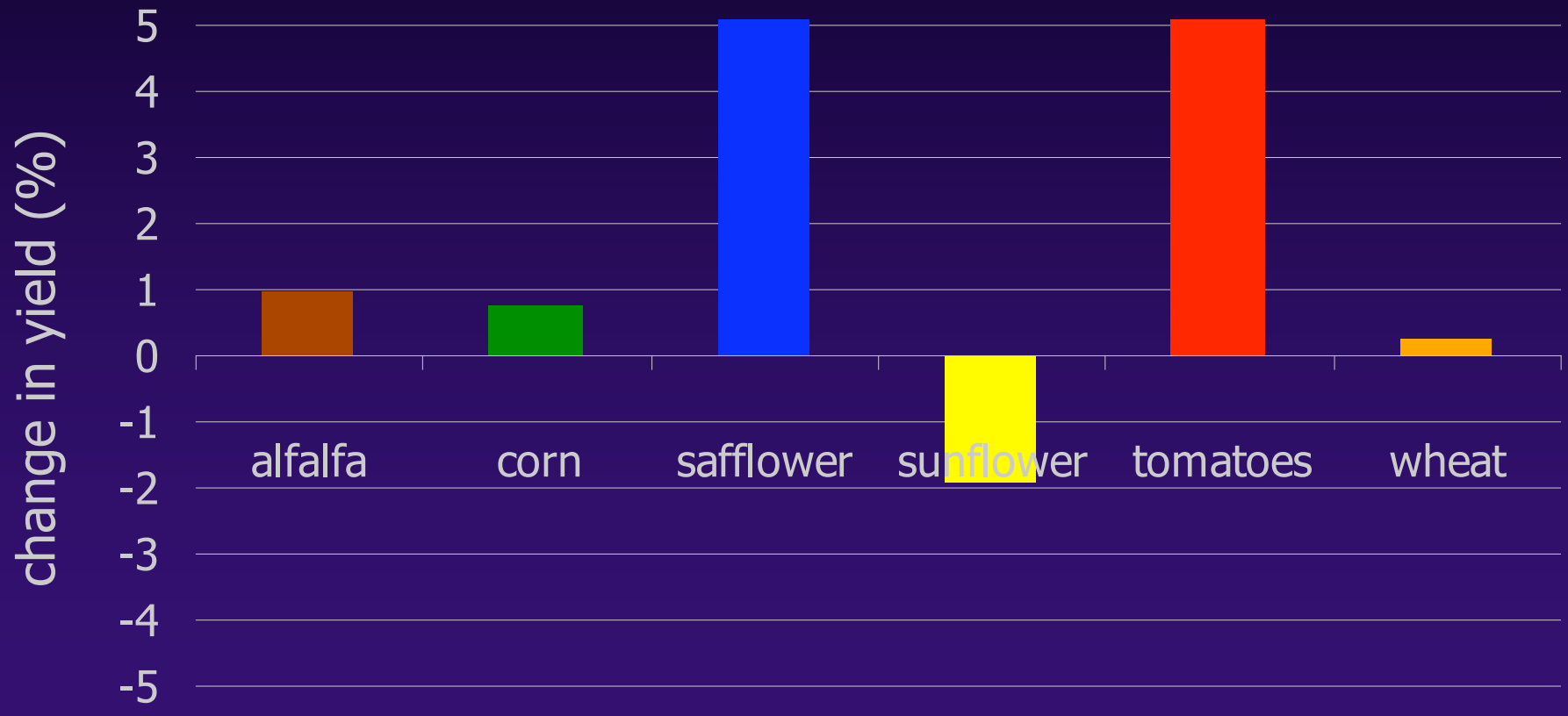
contribution of separate gases:

contribution of CO_2

contribution of N_2O



Results: conventional to winter cover cropping – change in yield



Results: conventional to winter cover cropping – GHG difference

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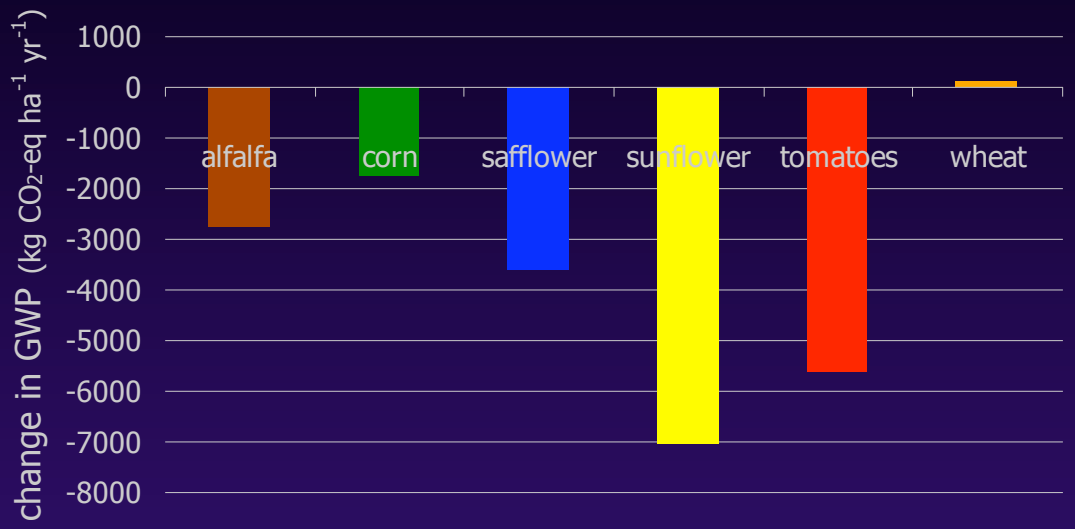

contribution of separate gases:

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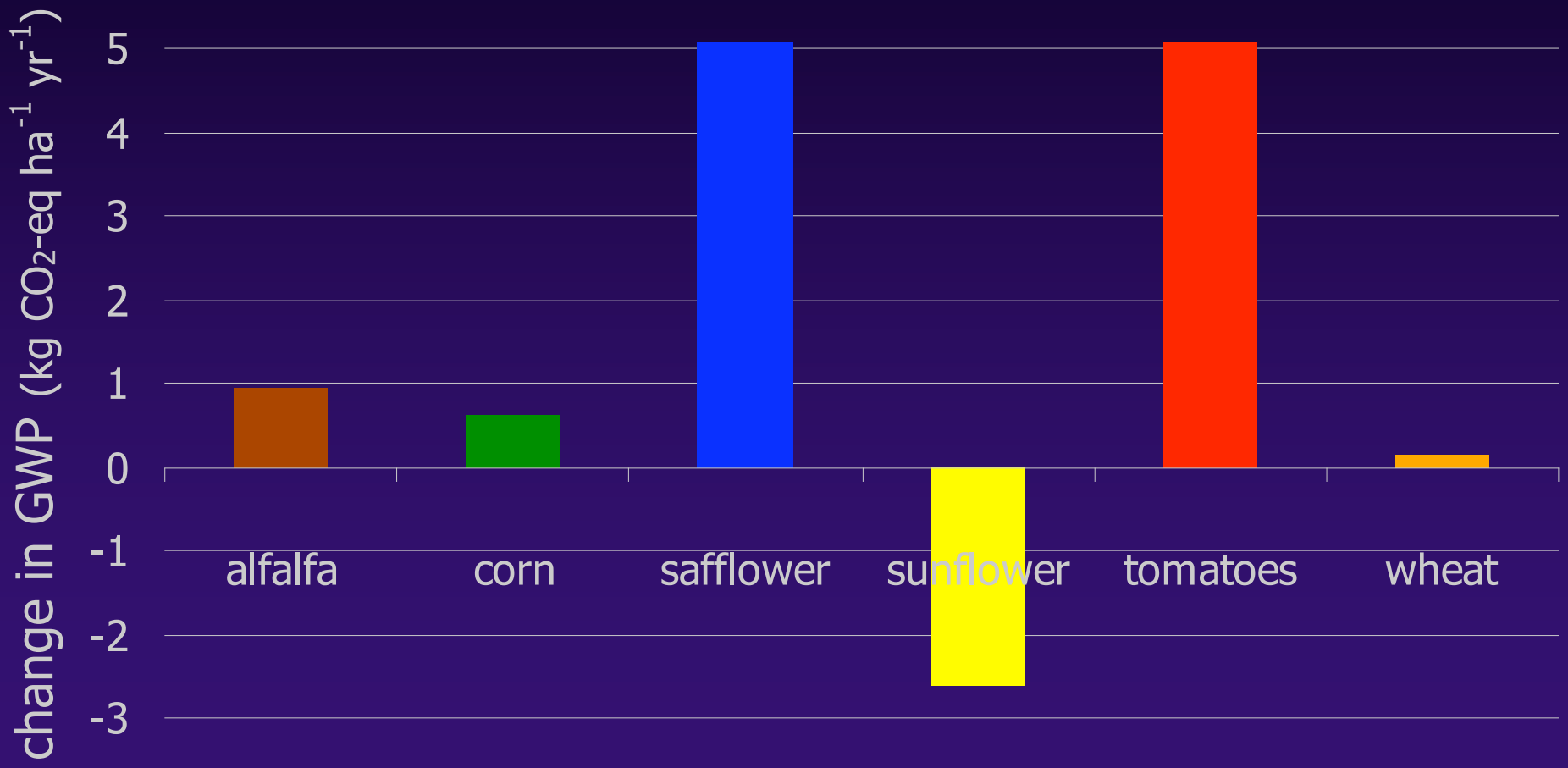
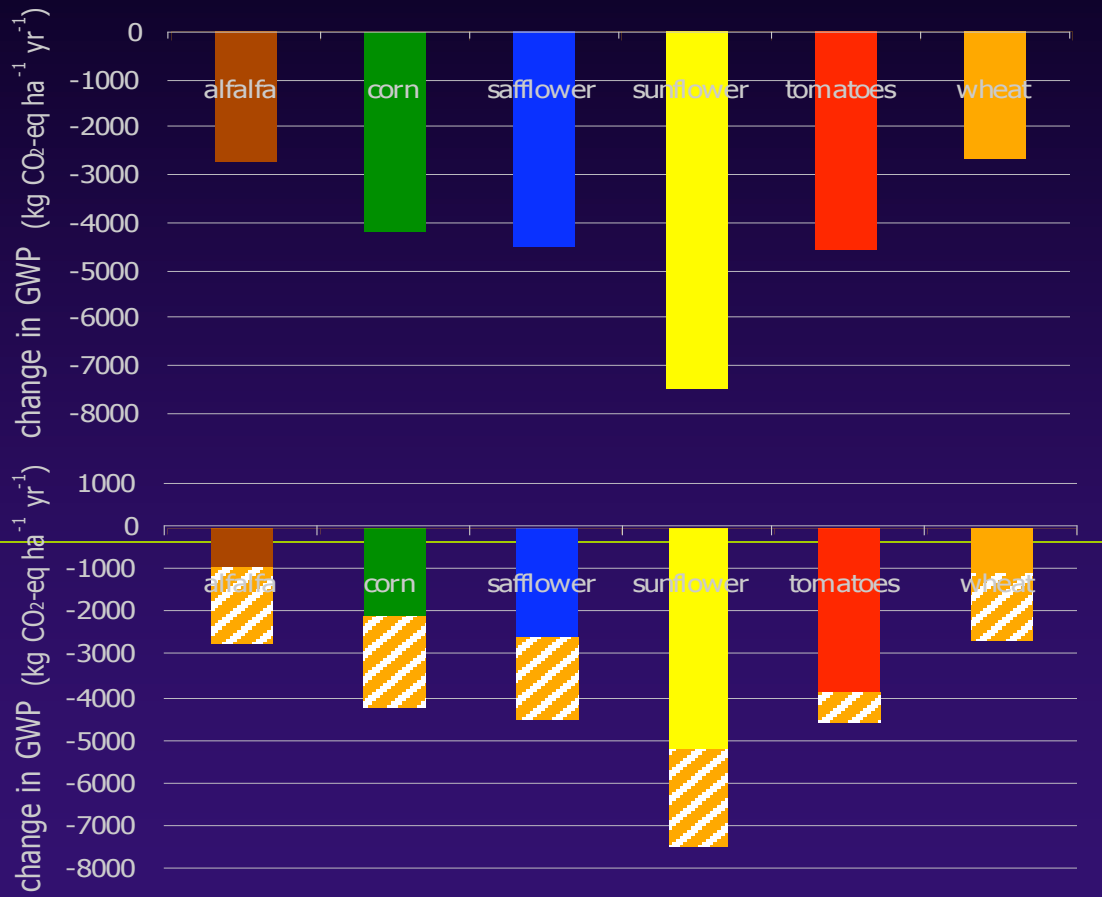
Results: conventional to organic – change in yield



Results: conventional to organic – GHG difference

total change:



contribution of separate gases:

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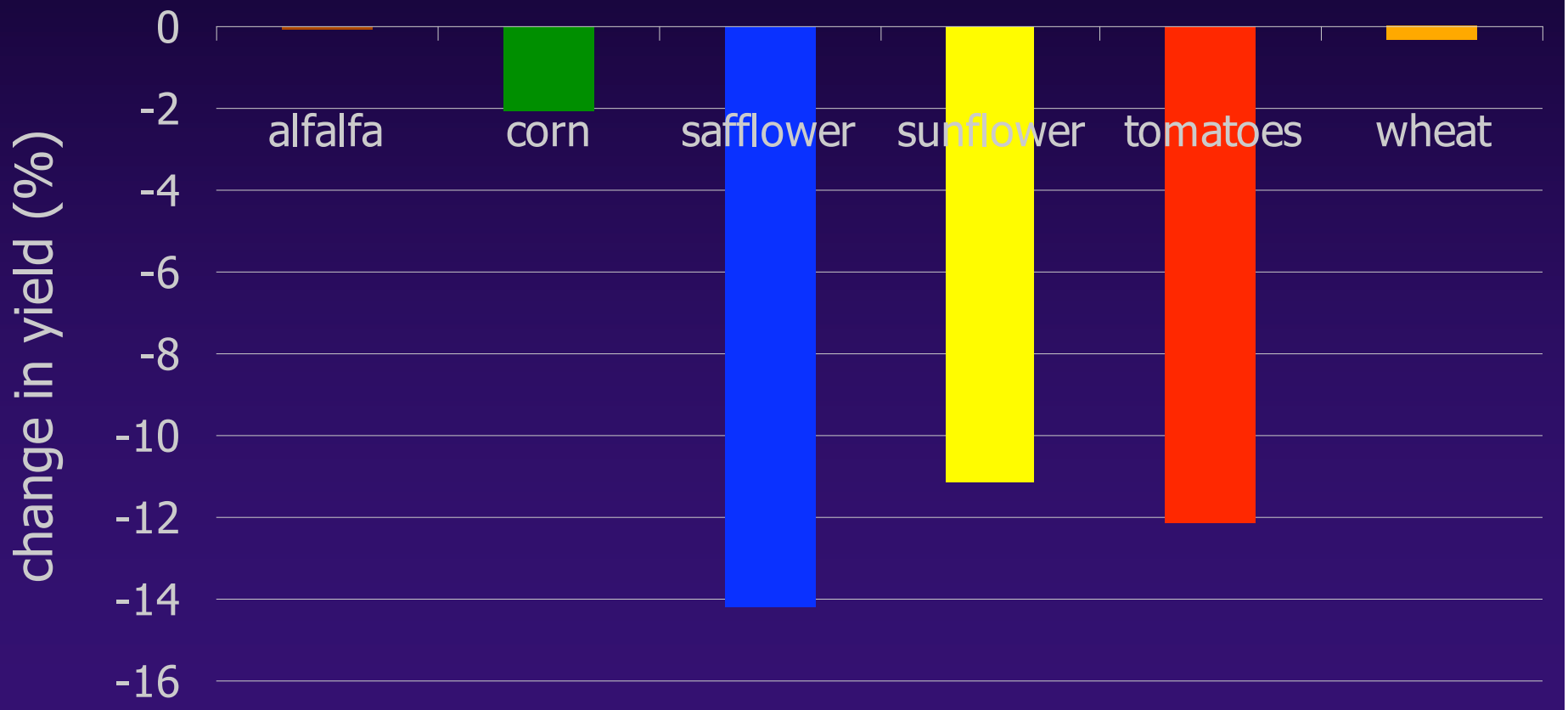
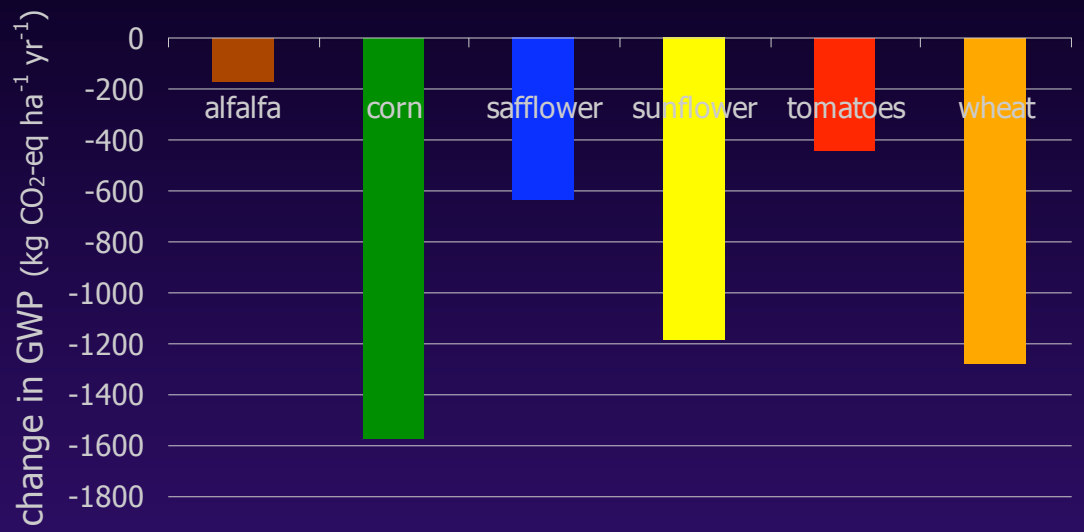
Results: conventional to low input – change in yield



Results: conventional to low input – GHG difference

total change:



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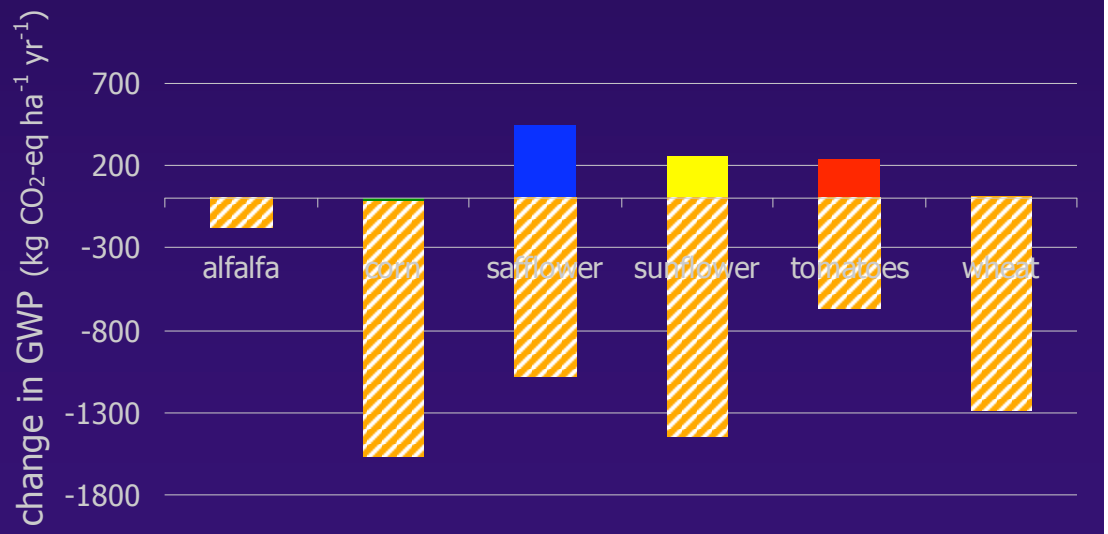


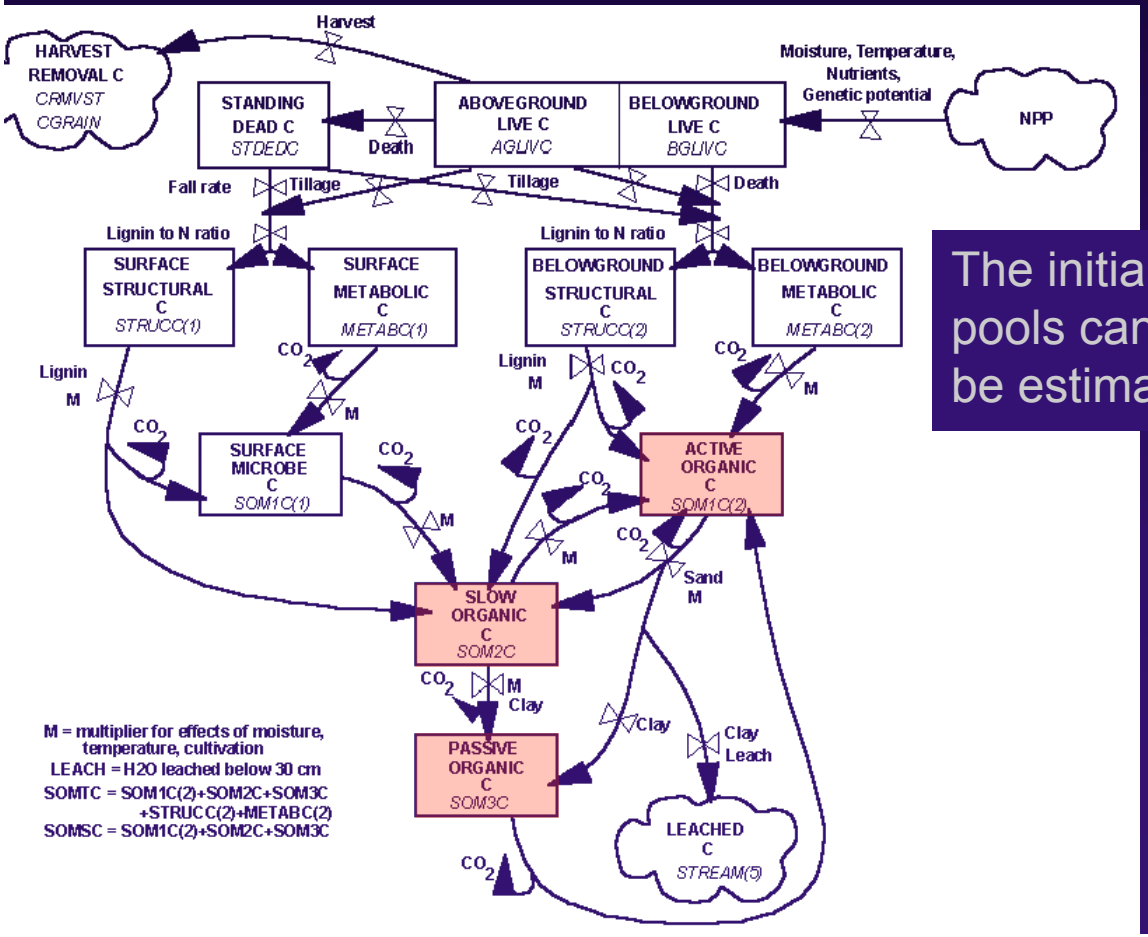
Conclusions

- Alternative management practices have a limited effect on yield, except for sunflower (but also least validation data)
- Greenhouse gas mitigation potential: reduced tillage < winter cover cropping < organic cropping
- Fertilizer reduction is a real option for grain crops
- Tomatoes seem to have most potential in Yolo
- Need for uncertainty analysis
- Need for assessing economic feasibility

-> Richard Howitt

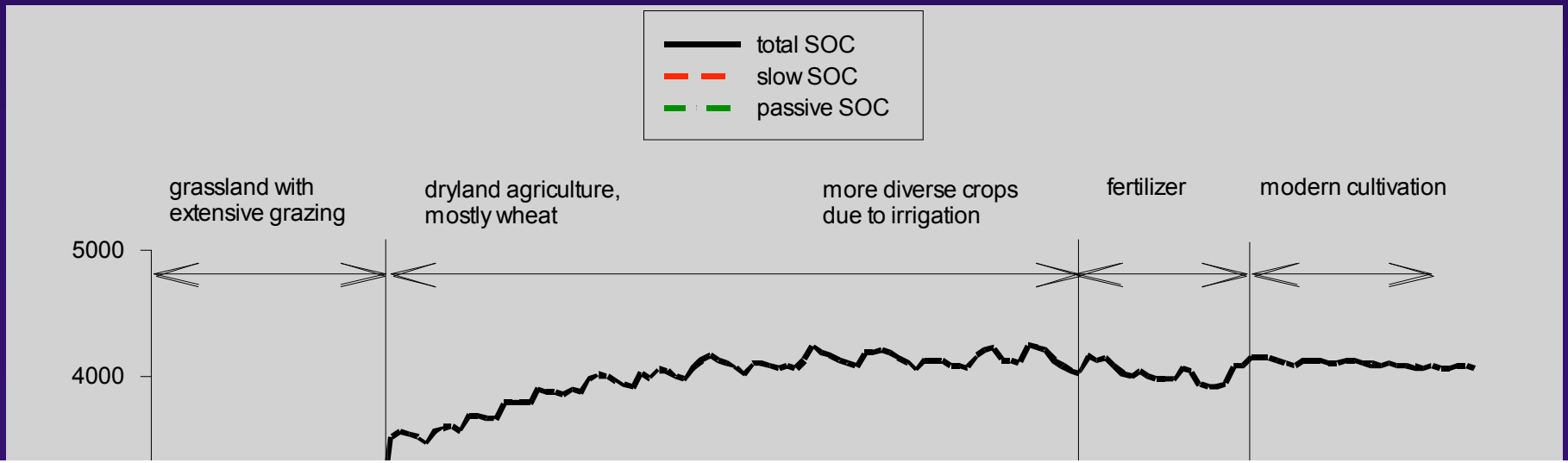
Initialization

- DayCent uses conceptual organic matter pools



The initial value of these conceptual pools can not be measured, but has to be estimated through historical runs

Historical runs



Cropping calendar for each practice

- (1) conventional practices (CONV)
- (2) reduced tillage (RT)
- (3) use of winter cover crops (WCC)
- (4) organic farming methods (ORG)
  = manure addition and winter cover crops

	management			
event	CONV	RT	WCC	ORG
herbicide in spring		15 Jan		
field cultivator (tandem disc)	15 Jan	15 Feb		
moldboard tillage	15 Feb		2 Apr (incorporates WCC)	2 Apr (incorporates WCC)
pre-irrigation	8 Apr	8 Apr	8 Apr	8 Apr
manure addition				15 Apr, 750 kg C ha^{-1}, 107 kg N ha^{-1}
planting day	15 Apr	15 Apr	15 Apr	15 Apr
starter fertilization	13.5 kg N ha^{-1}	13.5 kg N ha^{-1}	13.5 kg N ha^{-1}	
nr. of growing season cultivations	5	5	5	5
nr. of irrigation events	7	7	7	7
fertilization	7 May, 168 kg N ha^{-1}	7 May, 168 kg N ha^{-1}	7 May, 168 kg N ha^{-1}	
fertilization	14 May, 6.2 kg N ha^{-1}	14 May, 6.2 kg N ha^{-1}	14 May, 6.2 kg N ha^{-1}	
harvest	15 Sep	15 Sep	15 Sep	15 Sep
incorporate biomass			22 Sep	22 Sep
moldboard tillage	30 Sep		29 Sep	
plant legume WCC			4 Nov	4 Nov

Validation (3): soil carbon in 1996